PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to Fluid Controlled Devices

We, INTERNATIONAL BUSINESS MACHINES CORPORATION, a Corporation organized and existing under the laws of the State of New York in the United States of America, of Armonk, New York 10504, United States of America (assignees of RICHARD ELLIS NORWOOD) do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to a fluid-controlled device.

Many devices have been devised by which the pressure and flow of fluid can be controlled to operate valves and indicating apparatus. These devices are generally required to perform amplification and switching of fluid control signals and provide output signals of sufficient pressure to perform a function at a subsequent stage. The prior fluid controlled devices include those of the fluid amplifier type and the type in which a movable piston or vane is used to divert or stop fluid flow.

The object of the present invention is to provide an improved fluid controlled device.

According to the invention, a fluid controlled device comprises means defining a fluid flow path between an inlet and an outlet including two fluid flow restrictors and at least two chambers disposed between said restrictors, each chamber containing means operable by the application of a respective fluid pressure control signal to terminate the flow of fluid through said chamber, and at least one output channel connected to said fluid flow path between said rectrictors to provide an output signal which is a logical function of said fluid pressure control signals applied.

The invention will now be described with reference to the accompanying drawings, in which:—

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Figure 1 is a plan view of a fluid controlled device;

Figure 2 is a sectional view of the device shown in Figure 1 and taken along the lines 2—2 thereof;

Figure 3 is a plan view of a two stage arrangement of fluid controlled devices in which positive output control signals are provided for the fluid supply in response to either the presence or absence of a control signal;

Figure 4 is a schematic diagram of the device shown in Figure 3; and

Figures 5 to 8 are schematic diagrams of the OR, NOR, AND and NAND logic blocks which can be constructed in accordance with the invention.

Referring to Figures 1 and 2, there is shown the basic element of a fluid controlled device from which various logic control devices in accordance with the invention can be assembled. The device 10 comprises a laminar block 11 of imperforate material, such as a plastic or metal, having an entry flow path 12 leading to a chamber 13 that is provided with an exit flow path 14 therefrom. Extending from wall 15 to the chamber is a ridge 16 and secured to the opposite wall 17 is a thin, flexible diaphragm 18 of an elastic material such as rubber which forms a control compartment 19. The flow path is also formed with a restriction or flow resistance 20, which can be a blocking plate having a hole therein, in the input path 12 and a similar flow restriction 21 in the exit flow path 14. The hole size enables the chamber pressure to be regulated as desired. Communicating with compartment 19 is a control channel 22 through which control fluid pressure pulses P_c are directed.

Two output channels 23 and 24 are provided by which output signals are obtained in response to the input signals applied at control channel 22. The fluid pressure in

channel 23 is normally at the lower of two levels therein and the fluid at channel 24 is at the higher of two levels when no control signals appear in control channel 22. In this instance fluid from a suitable pressure-regulated supply P_s flows through restriction 20, around ridge 16 by deflecting diaphragm 18, and out through exit restriction 21 to atmosphere or a suitable pressure sink P_a.

The fluid pressure P_1 or P_2 in either of the respective output channels 23 or 24 is of the same pressure. When a pressure signal appears in channel 22 which is sufficient to seal diaphragm 18 against ridge 16, output channel 24 is effectively cut off from the supply pressure and thus its pressure will drop substantially instantly to atmospheric. The pressure in output channel 23 will rise approximately equal to the supply pressure.

The diaphragm valve of device 10 does not require a high volume of fluid because of the resistances 20 and 21 which tend to limit flow when the device is open. Fluid, of course, does not pass to the atmosphere through exit channel 14 when the diaphragm is closed. When the output channels 23 or 24 serve as control ducts in subsequent devices, there is usually no fluid flow in those channels because they are terminated in respective diaphragm chambers where only the pressure of the output signals is indicative of the signal transmitted.

It will be evident that both output channels of the device 10 may be used together or only channel 23 or 24 can be used separately, depending upon the desired function to be attained. For example, the output from channel 24 is the inverse of the control pressure so that the invert function can be achieved. Assuming that channel 23 is blocked or eliminated, flow occurs from the supply pump through resistance 20, through the diaphragm chamber and out through fluid resistance 21. The diaphragm 18 presents no impedance to fluid flow since it is open. If the diaphragm tension is assumed to be negligible in the deflected position, as by preforming the diaphragm, and that the fluid resistances 20 and 21 have been set so that pressure at P_2 is a fraction such as 80% of the supply pressure, then the total force urging the diaphragm open is the pressure P_2 times the areas A_1 plus A_2 (FIG. 2). As the control pressure P_c is increased, it will have no effect until the control pressure times the area of the diaphragm exposed in compartment 19 equals the pressure P_2 times the area of the diaphragm. As soon as the control pressure exceeds the ratio of 0.7 times the supply pressure, the diaphragm snaps over against ridge 16. The force counteracting the control pressure is only the area A_1 multiplied by the supply P_s at that time.

When control pressure P_c is reduced, the diaphragm will remain closed until it reaches such value that the area A_1 times the supply pressure P_s exceeds the control pressure times the entire area A_1 plus A_2 of the diaphragm. It can be seen that when the control pressure P_c closes off chamber 13, the output pressure P_2 at channel 24 goes to atmospheric pressure P_a. Thus the device may be used to perform the inversion function of input control signals.

When it is desired to use device 10 as an amplifier, output channel 24 may be eliminated or disregarded and channel 23 used to provide the output signal in which the fluid pressure is P_1. The output pressure P_1 is preset by the fluid impedances 20 and 21 so that the output pressure is approximately 0.2 of the supply pressure P_s. As the control pressure P_c is increased, the output pressure P_1 acting on area A_1 will increase while the pressure acting on area A_2 will decrease. The output pressure will vary so as to keep the total resultant force on the diaphragm at zero if we again assume there is no diaphragm tension. When the control pressure P_c becomes greater than one-half the supply pressure P_s, the diaphragm will seal off the flow. The output pressure P_1 will thus be at the pressure of the supply which is acting on only one-half the area of the diaphragm while the input control signal P_c is at a pressure only half that of the supply. When the device 10 is used as an amplifier, it is desirable that the downstream impedance or fluid restriction 21 be kept low relative to the upstream impedance 20, preferably in a ratio of a tenth of the upstream impedance.

Diaphragm device 10, as illustrated in FIGS. 1 and 2, is readily adaptable for positively controlling the transfer of power in another stage of diaphragm devices as shown in FIG. 3. In this arrangement the two outputs 23 and 24 from device 10 are each connected to the control ports 30 and 31 of respective diaphragm elements 32 and 33. These elements are, in turn, connected together serially between a fluid supply of pressure P_s and the atmosphere. No flow resistances are used in this arrangement in order to deliver the maximum pressure as an output signal at junction 35 intermediate the two devices.

When a control pressure pulse at control channel 22 closes diaphragm 18, the pressure in channel 23 moves toward the supply pressure. The pressure is also effective at device 32 to start closing diaphragm 36. When diaphragm 18 does close, the pressure in channel 24 starts to decrease permitting diaphragm 37 of device 33 to open. For a brief time both diaphragms 36 and 37 are open producing pressure drop through the two serial devices. This loss of pressure is sufficient to permit the control pressure of channel 23 to close diaphragm 36 in device 32 and maintain it closed. The supply pressure from channel 23 which is approaching

P_s is effective over the entire service of diaphragm 36 while the same pressure P_s is effective on only half the area of the opposite side. The output pressure signal at junction 35 thus falls to atmospheric.

When the control signal on channel 22 is removed, flow resumes through device 10 and the pressure in channel 24 increases which acts on diaphragm 37. The flow through device 10 permits diaphragm 36 in device 32 to open so that both devices 32 and 33 are open temporarily producing a pressure drop across the devices. As a result, the pressure in channel 31 is operable to close diaphragm 37. The supply pressure acts only on the upstream area of diaphragm 37 because there is no resistance in the exit channel. Thus all presure drop occurs across the ridge in diaphragm 37. Thus, the pressure of output 35 increases to the supply pressure P_s. With device 10 connected in the manner described, one of diaphragm devices 32 or 33 is closed whether or not a signal is present at control channel 22.

Various logic elements may be constructed by considering the device discussed above. These elements are illustrated in FIGS. 4 through 8. FIG. 4 is merely a schematic representation of the device shown in FIG. 1 in which the electrical resistance symbol is used to represent fluid impedances 20, 21 and a circular symbol denotes the diaphragm logic device and input control signal. The supply pressure is indicated by P_s and the exhaust for atmospheric pressure is represented by P_a. This symbology is carried forward into the examples shown in FIGS. 5 through 8 in which the OR and NOR elements are shown in FIGS. 5 and 6, with the AND and NAND elements shown in FIGS. 7 and 8.

In the OR device of FIG. 5, a plurality of diaphragm devices 40 and 41 are connected serially between upstream and downstream fluid resistance. The output P_0 in this case is taken immediately after the upstream resistance so that the output signal will rise in pressure at any time one of the diaphragm devices receives a fluid signal of sufficient pressure to close off the stream flow from the supply to atmosphere. The output signal will rise in pressure at the same time the input control signal rises. The NOR device of FIG. 6 is similar to the OR device except that the output signal is taken between the last diaphragm device and the downstream fluid resistance element. At any time one of the intervening fluid diaphragm devices is cut off by a control signal the output pressure will go down to atmospheric pressure, thus providing an inverted signal compared to the input control signal.

The AND device of FIG. 7 incorporates multiple diaphragm devices 42 and 43 but these devices are connected in parallel between the upstream and downstream fluid resistance. In order to receive the positive-going or increasing output signal pressure, the output is taken intermediate the upstream fluid resistance and the diaphragm devices. No output signal will occur until all devices of the diaphragm units have received a control signal to block fluid flow therethrough at which time a positive-going output pressure signal will result. In the NAND device of FIG. 8 the diaphragm elements are arranged in a similar manner except that the output pressure signal is taken intermediate the parallel-connected diaphragm devices and the downstream impedance. An inverted output signal is provided when all diaphragm devices receive positive-going control pressure signals. It can be seen that each of the outputs of the logic devices can be connected to operate subsequent stages as desired. For example, the OR and NOR devices can be substituted for device 10 in FIG. 3 by the addition of another output channel.

These devices can, of course, be arranged in various combinations to provide the response desired upon the occurrence of specified conditions. Since the diaphragm devices do not require a large supply of fluid because of the reliance on pressure changes and restricted flow, many devices may be added to enlarge the capacity of the control system without requiring a larger capacity supply.

It is to be noted that while the diaphragm devices have been illustrated as constructed of rectangular chambers, they may also be constructed with concentric inlet and outlet channels separated by a common wall. The diaphragm would overlie the both channels in this instance and be engageable with the wall to control fluid flow from one to the other of the channels.

WHAT WE CLAIM IS:—

1. A fluid controlled device comprising means defining a fluid flow path between an inlet and an outlet including two fluid flow restrictors and at least two chambers disposed between said restrictors, each chamber containing means operable by the application of a respective fluid pressure control signal to terminate the flow of fluid through said chamber, and at least one output channel connected to said fluid flow path between said restrictors to provide an output signal which is a logical function of said fluid pressure control signals applied.

2. A fluid controlled device according to claim 1, in which each means to terminate the flow of fluid includes a flexible diaphragm disposed in the associated chamber and operable by the fluid pressure control signal supplied through an input channel connected to said chamber.

3. A fluid controlled device according to Claim 2, in which said means further includes

a ridge formed in said chamber against which the diaphragm is adapted to lie, when the fluid pressure control signal is supplied through said inlet channel, to terminate the flow of fluid through said chamber.

4. A fluid controlled device according to any of the preceding claims, in which the output channel is connected to said fluid flow path between the restrictor adjacent said inlet and the nearest fluid flow terminating means.

5. A fluid controlled device according to any of claims 1 to 3, in which the output channel is connected to said fluid flow path between the restrictor adjacent said outlet and the nearest fluid flow terminating means.

6. A fluid controlled device according to any of the preceding claims, including at least two chambers connected in parallel between said restrictors.

7. A fluid controlled device according to any of claims 1 to 5, including at least two chambers connected in series between said restrictors.

8. A fluid controlled device substantially as hereinbefore described with reference to any one of Figures 5, 6, 7 and 8 of the accompanying drawings.

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Agent for the Applicants.

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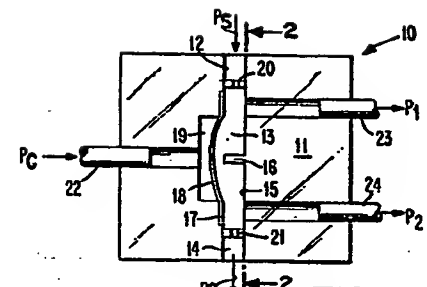

FIG. 1

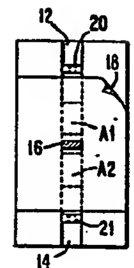

FIG. 2

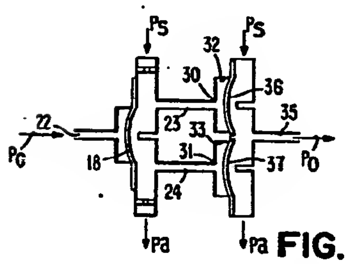

FIG. 3

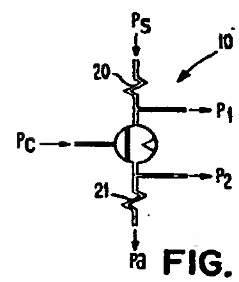

FIG. 4

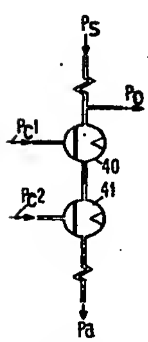

FIG. 5

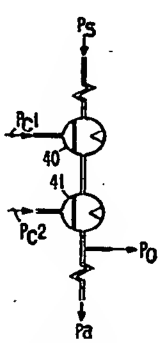

FIG. 6

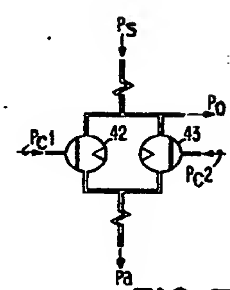

FIG. 7

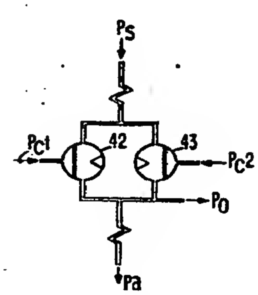

FIG. 8